# Remote Sensing Data Products Now Available for Carbon Cycle and Ecosystems Science

**LAND** 

Rama Nemani Ames Research Center http://ecocast.arc.nasa.gov **OCEANS** 

**James Acker** 

**Goddard Earth Science Data and Information Services Center** 

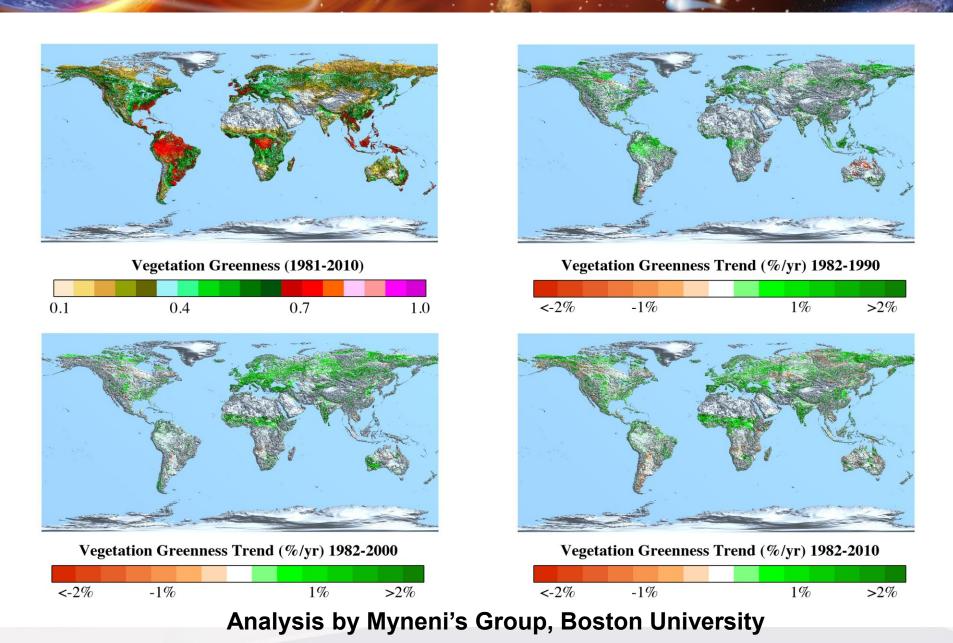
http://disc.sci.gsfc.nasa.gov/



NASA Carbon Cycle & Ecosystems

Joint Science Workshop, October 3, 2011

# 30 Years of Vegetation Greenness Measurements Produced by Tucker's GIMMS Group, GSFC/NASA



# Largely a Greening Planet With hints of browning

IGBP Land Cover Classes	GSI NDVI (%)	GSI NDVI (%)	GSI NDVI (%)
	(1982-1990)	(1982-2000)	(1982-2010)
Evergreen Broadleaf forest	(5.8, <mark>0.0</mark> ,6.7)	(1.4, <mark>0.1</mark> ,11.1)	$(4.4, \frac{0.4}{0.1}, 7.7)$
Woody savannas	(2.0, <mark>0.2</mark> ,9.7)	(2.1, <mark>0.5</mark> ,9.3)	(3.3, <mark>1.5</mark> ,7.2)
Croplands	(2.3, <mark>0.2</mark> ,8.1)	(3.6, <mark>0.3</mark> ,6.6)	(4.1, <mark>1.0</mark> ,5.4)
Open shrublands	(2.9, <mark>0.7</mark> ,12.9)	(4.6, <mark>0.3</mark> ,11.5)	(5.2, <mark>2.3</mark> ,8.9)
Grasslands	(1.6, <mark>0.4</mark> ,11.1)	(3.2, <mark>0.2</mark> ,9.6)	(4.0, 1.3, 7.8)
Savannas	(0.6, 0.3, 7.0)	(1.4, <mark>0.4</mark> ,6.2)	(2.1, 0.9, 5.0)
Croplan d/Natural vegetation mosaic	(1.3, <mark>0.1</mark> ,5.1)	(1.8, <mark>0.2</mark> ,4.5)	(2.4, 0.5, 3.6)
Mixed forest	(1.4, 0.1, 4.3)	(2.0, 0.2, 3.6)	(2.9, <mark>0.3</mark> ,2.6)
Evergreen Needleleaf forest	(1.1, 0.2, 3.9)	(1.4, 0.5, 3.3)	(1.8,1.0,2.4)
Deciduous B roadleaf forest	(0.3, 0.0, 1.3)	(0.3, 0.1, 1.2)	(0.5, 0.2, 0.9)
Deciduous Needleleaf forest	(0.4, 0.1, 1.6)	(0.7, 0.1, 1.3)	(0.5, 0.5, 1.1)
Closed shrublands	(0.2, 0.0, 0.9)	(0.2, 0.0, 0.9)	(0.2, 0.2, 0.7)
Total	(19.9, 2.5, 72.5)	(22.6, 2.9, 69.0)	(31.4,9.8,53.3)



### **Area fractions only**

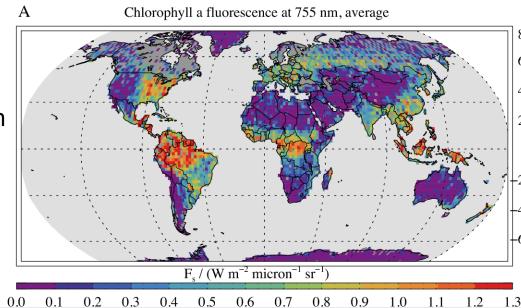
Analysis by Myneni's Group, Boston University

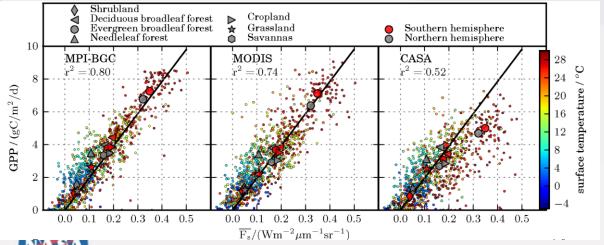
### Satellite Measurements Of Chlorophyll Fluorescence

Frankenberg et al., GRL, 2011

Chlorophyll fluoresces when performing photosynthesis -> signal can be measured using high resolution O<sub>2</sub> A-band spectra (GOSAT, OCO-2)

New satellite based fluorescence measurements provide a spatial constraint on carbon uptake

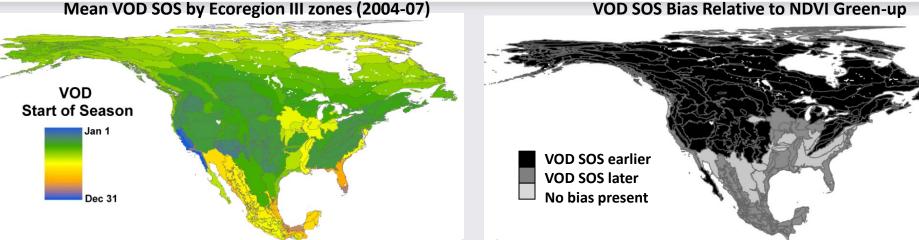




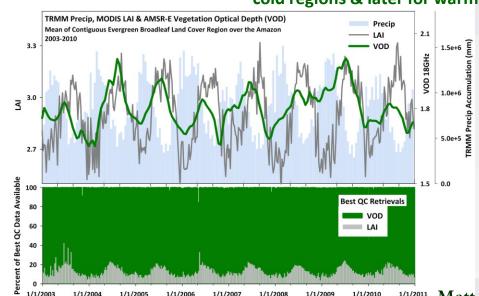
Uncertainty exists around absolute magnitudes, Welp et al' suggest 150-175 Pg of GPP compared to current estimates of 100-120 Pg



### Microwave Vegetation Optical Depth (VOD) Phenology from AMSR-E



 VOD start of season (SOS) & NDVI green-up metrics are well correlated but have seasonal bias; SOS earlier than green-up for cold regions & later for warmer, drier regions;



- AMSR-E VOD is sensitive to canopy water content & biomass changes, & is correlated with MODIS LAI;
- The VOD is insensitive to atmosphere (clouds, smoke) effects, enabling near-daily vegetation monitoring;
- The Amazon shows large VOD seasonality & dry-season canopy growth, but reduced growth under a large 2010 drought.

http://freezethaw.ntsg.umt.edu

Matt Jones, John Kimball, Lucas Jones & Kyle McDonald

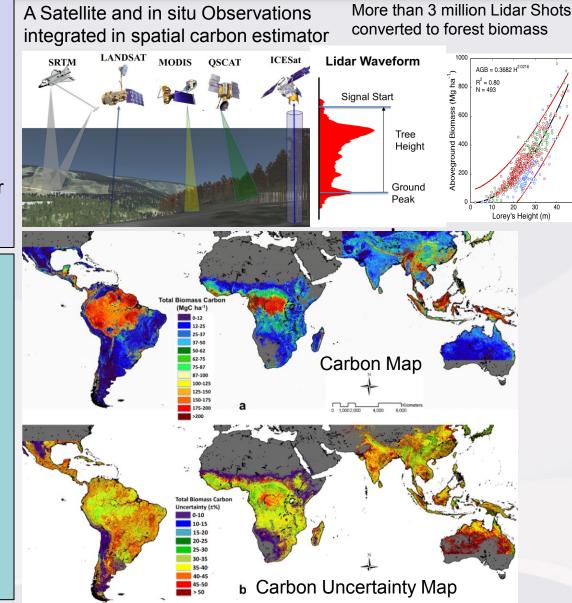
### A Benchmark Map of Carbon Storage in Tropics

Saatchi et al. PNAS 2011

Different NASA satellites including more than 3 million ICESAT GLAS Lidar measurements of forest height are used to create the most precise map depicting where -- and how much -- carbon is stored in Earth's tropical forests. The high-resolution map is expected to provide a baseline for ongoing carbon monitoring and research, and serve as a useful resource for managing the greenhouse gas carbon dioxide.

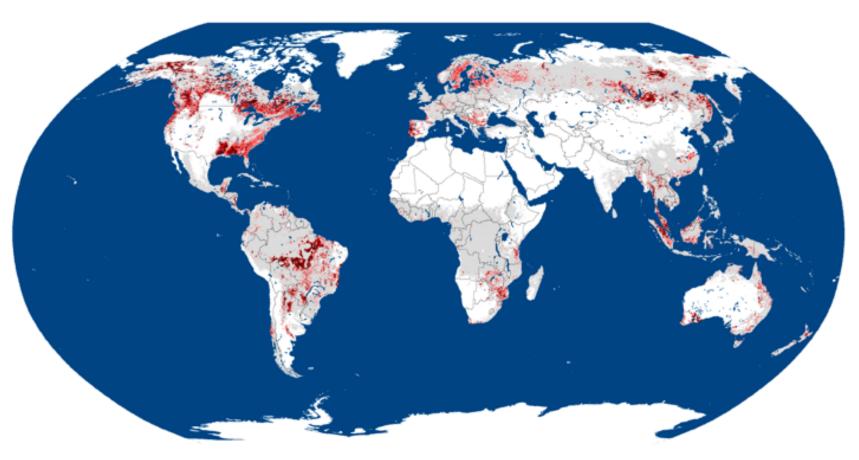
#### **Highlights:**

- 1. The map shows that in the early 2000s, forests in the 75 tropical countries studied contained 247 billion tons of carbon or an equivalent of 900 billion tons of carbon dioxide. For perspective, about 35 billion tons of carbon dioxide is released to the atmosphere annually as a result of human activities.
- 2. Forests in Latin America hold 49 percent of the carbon in tropical forests. For example, Brazil's carbon stock alone, at 61 billion tons, almost equals all of the carbon stock in sub-Saharan Africa, at 62 billion tons.



### Quantification of global gross forest cover loss Hansen et al., PNAS, 2010

### Percent forest cover loss, 2000 to 2005





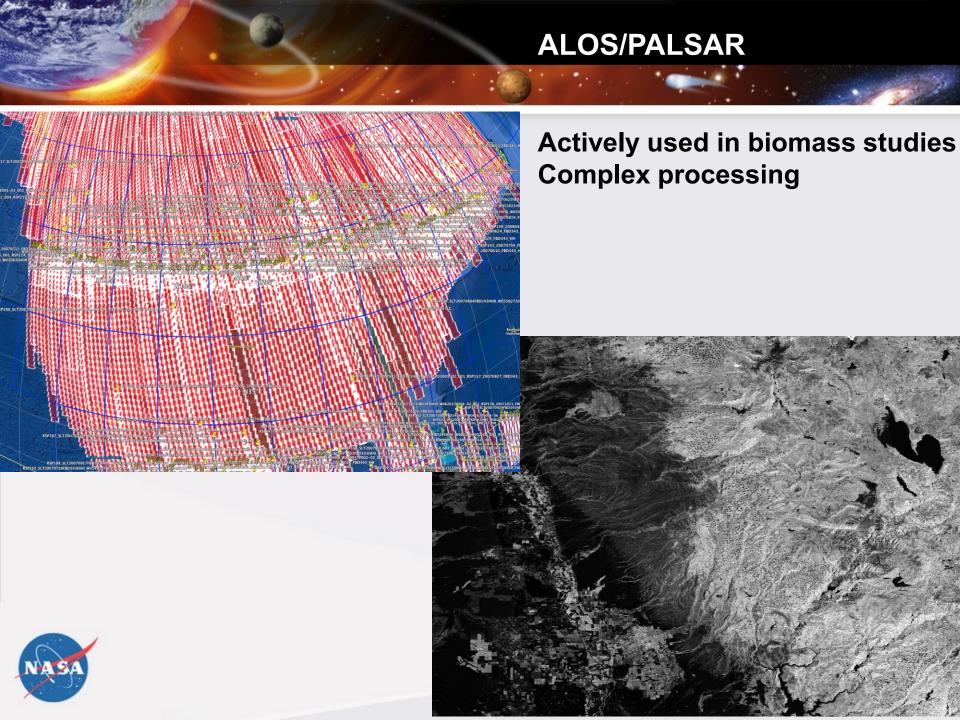
0 - 1.5%

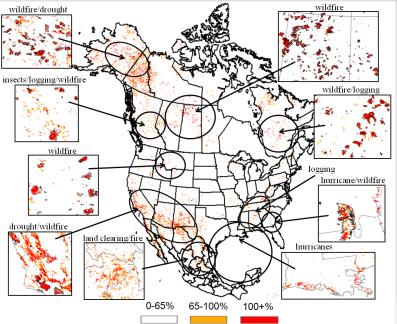
1.5 - 5% 5 - 10%





>10%





## **MODIS Disturbance Index Mildrexler et al., 2009, RSE**

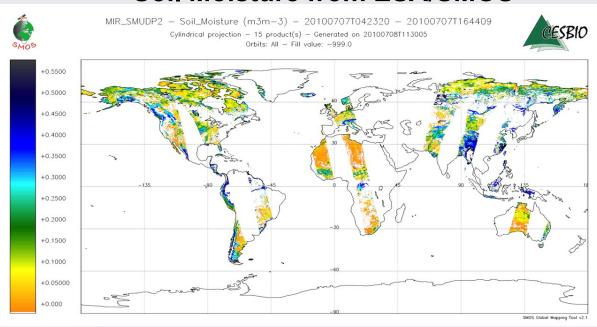
QuickTime™ and a decompressor are needed to see this picture



MODIS Evapotranspiration Mu et al., 2011, RSE

Global Crop Lands, Pittman et al., 2011, RSE

#### **Soil Moisture from ESA/SMOS**



#### **Surface Emissivity**

QuickTime™ and a decompressor are needed to see this picture.



http://lst.jpl.nasa.gov/about

# NGA Commercial Archive Data

Access to High-Resolution Data for NASA Earth Science Investigators

- National Geospatial Intelligence Agency (NGA) Commercial Archive contains 4+ million high resolution (<1m) images.
- Global coverage exists between IKONOS, GeoEye 1, Quickbird, Worldview 1, & Worldview 2 satellites.
- Currently Beta testing data distribution to the LCLUC community, soon it will be a resource for all NASA Investigators.

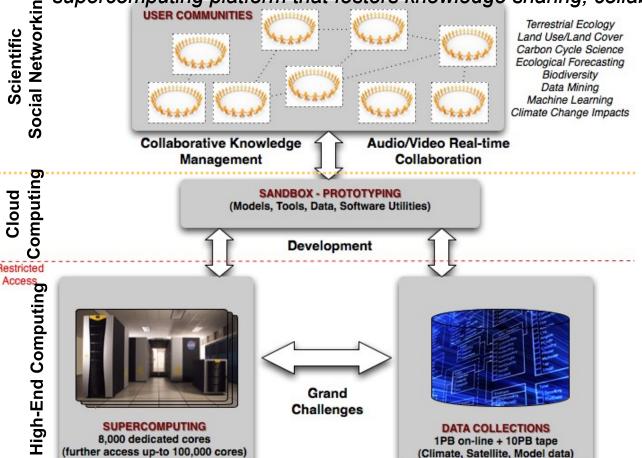


### NASA Earth Exchange

Collaborative supercomputing for global change science

Providing direct access to data, models, analysis tools, and scientific results through a

supercomputing platform that fosters knowledge sharing, collaboration, and innovation. Social Networking



Scientific

Computing

Restricted

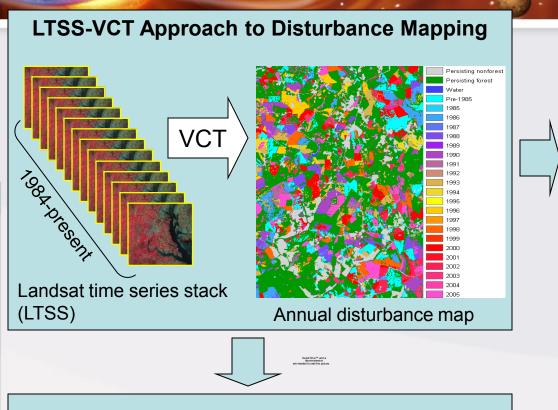
Scientists spend nearly 80% of their time dealing with data - less than 20% on analysis work towards 20/80

By

- Moving the code to where data is
- Sharing/re-using code
- Capturing and sharing the workflows

Currently NEX has 200 members and 22 research teams

## North American Forest Dynamics Disturbance Products http://www.geog.umd.edu/nacp.goward/

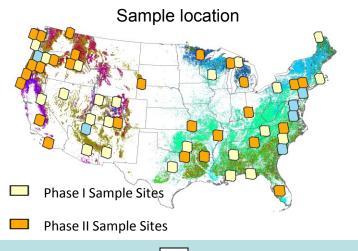


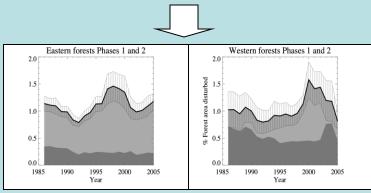
#### NAFD Phase III (2011-2014)

- Wall-to-wall disturbance mapping for conterminous US, annual step, Landsat resolution
- Characterization of disturbance type and intensity
- Post-disturbance recovery analysis

#### NAFD Phase I & II

- Disturbance mapped at ~50 sample locations
- Disturbance rates estimated from the samples

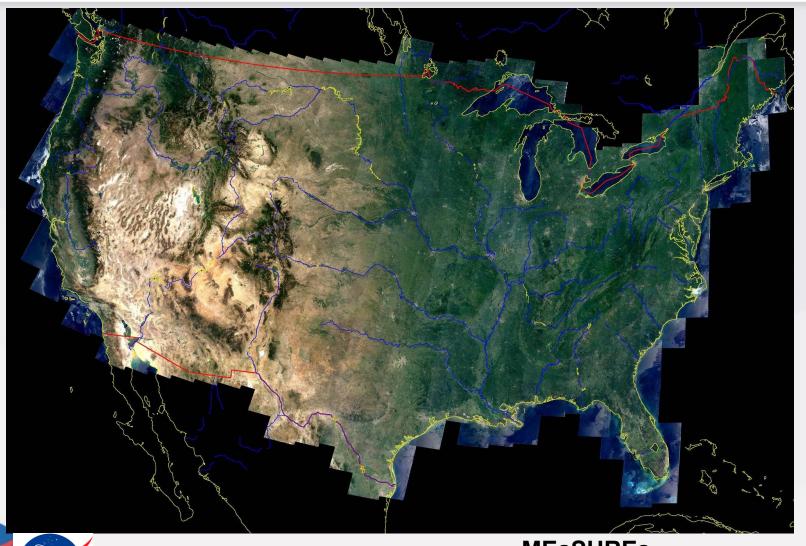




Disturbance rates in eastern and western US

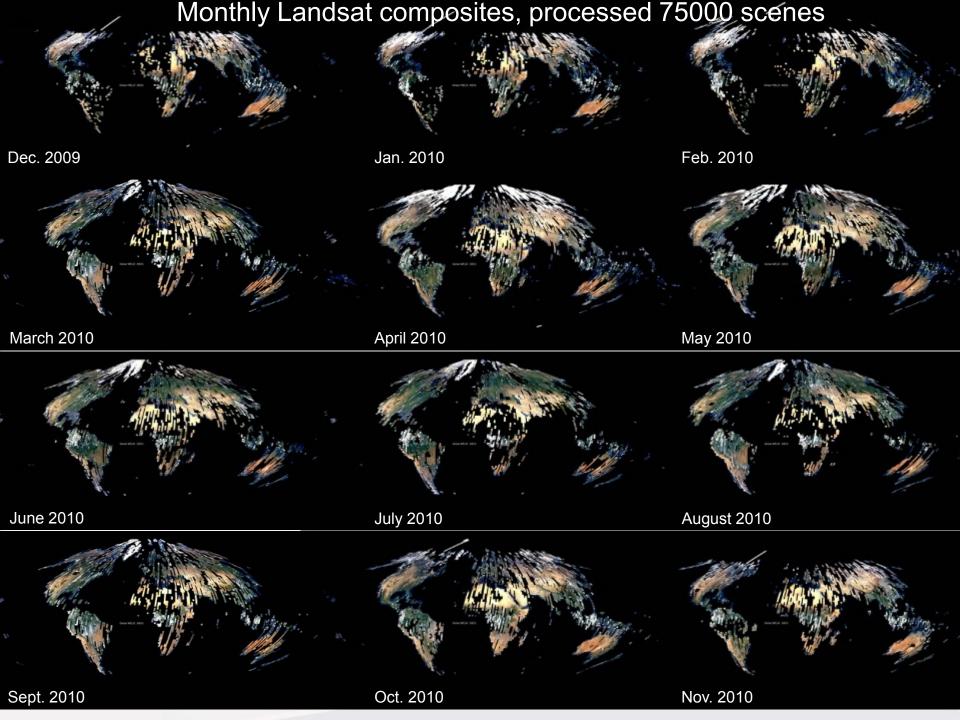
### WEB-ENABLED LANDSAT DATA (WELD)

Roy et al., Remote Sensing of Environment. 2010





**MEaSUREs,** globalmonitoring.sdstate.edu/projects/weld/



Host of new data, beyond EOS standard products, are available for CC&E community

Collaborative computing infrastructure is now available for creating/testing new products

Need for better coordination between producers and consumers of the new products

Need a framework for judging the utility of the new products

